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Motivation Mechanism of Accident Prevention in Coal Mine

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Abstract

On the basis of the analysis of accident situation and causes in mining industries, a study on unsafe behaviors was made, which showed that stimulating safe behaviors and restraining unsafe behaviors would not only greatly improve human reliability, but also reduce unexpected circumstance and accident frequency in the work. Based on behavior science and motivation theory, the thinking thread and framework for constructing coalmine safe behavior motivation system was presented according to the coalmine accident prevention mechanism and the relationship between motivation and safe behaviors. This study is helpful to the reduction of coalmine accidents or injuries and the improvement of safety performance in mining industries.

Keywords: Coalmine, Accident prevention, Accident causation, Motivation theory, Safe behavior

1.Introduction

Workplace fatalities and injuries bring great losses to both individuals and societies. For example, every year 10 million of the 150 million workers in the European Community are affected by accidents or diseases at work. In the United States, work-related injuries have been estimated at $125 billion per year. 17 employees die every day as a result of industrial accidents- a total of 63,589 deaths from 1980-1989. In 1992 alone 3.3 million work-disabling injuries were reported, and some 370,000 employees suffered work-related injuries [1].

Safety in the mine industry has been considered an important issue, with coal mine being one of the most dangerous industries. This is especially so in China, where, safety is a major concern because of the high accident rate [2-3]. Although in recent years, the whole safety situation of coal mines throughout the country tends to better, every year thousands of miners suffer injuries or death in China. According to recent accident statistics, 188 major coal accidents occurred from 2002 to 2006, average one in 4.7 days. In 2005, the death number of the global coal accidents is about 8,000, in China alone is as much as 6,434, and accounts for 80%. Every year the economic loss which caused by all classes of coal mine accidents in China is about RMB 30 billion. The alarming numbers indicate an urgent need for improving coal mine safety.

In China, regardless of the research efforts devoted, mining zones remain a serious safety concern for government agencies, legislatures, the mining industry, and the public. Although traditional approaches on the prevention of accidents/injuries in mines have been responsible for some significant improvement in safety over the years, it reached its limit of effectiveness in improving safety performance and a fresh approach is considered essential in the area of coalmine safety. The behavioral safety analysis (behavior based safety) has, therefore, been identified as an effective alternative in many industries [4-6]. The traditional safety methods give emphasis on the accident itself and management styles. Many mine safety management believed that accidents/injuries are due to hazardous nature of mining and only engineering control and regulatory monitoring are sufficient for improving safety of the mines, whereas the behavior-based safety believes that

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focusing on safe work behaviors lead to reduction of at-risk-behaviors and, ultimately reduced accidents and injuries. The behavioral approach not only emphasizes the pinpointing of desired performance but also provides a positive means of motivating workers to perform in a consistently safe manner. However, studies on behavior of mine safety are still rather limited. Recent studies suggest that there should be more in-depth studies and analysis of safety behavior need to device ways and means to further reduce the accidents/injuries in mines. Therefore, based on the analysis of mining and non-mining industries, the motivation theory was put forward in accident/injures prevention in mines. It will have important meaning to reduce accidents/injuries and improve safety performance of mining industries.

2. Causation analysis of coal mine accidents/injuries

Heinrich's accident causation theory [7] has provided the basis of classifications of safety accident causes. He reported his discovery from case studies of 70,000 accident records that 88% of all industrial accidents were caused primarily by unsafe acts of persons; 10% by unsafe conditions; and 2% by acts of God. Petersen has summarized the work of Heinrich in two points: (1) people are the fundamental reason behind accidents and (2) management is responsible for the prevention of accidents. De Reamer (1980) has grouped the causes of accidents into two categories: immediate causes of accidents and contributing causes of accidents. The former includes unsafe acts and unsafe conditions, while the latter includes mental and physical conditions of the workers and the management policies [8].

As its definition indicates, hazard is real or potential cause of accidents. Therefore, hazard factors can be classified by referring to the classification of accident causes. All on-site hazards are grouped into two categories: immediate factors and contributing factors. An immediate hazard factor is a factor that can cause an accident physically and directly, whether the accident happens or not, including unsafe acts and unsafe conditions. A contributing hazard factor is a factor that can further explain immediate hazard factor, including safety management policy, manager and worker's mental or physical conditions, initial mining site conditions, and so on, see Fig.1.

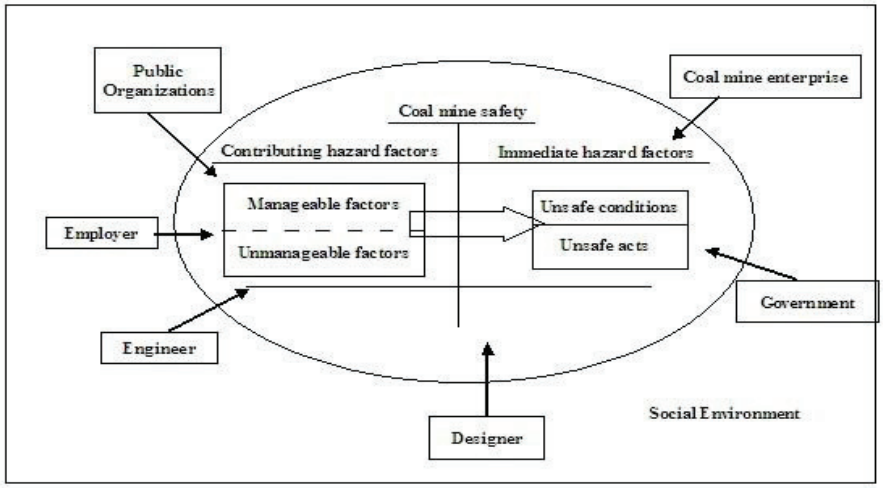

Fig.1 Hazard factors on coal mine safety

The notion that the vast majority of accidents are caused by unsafe work behavior or human errors has been supported by many researchers [9]. It is widely accepted that unsafe behavior is intrinsically linked to coalmine accidents. A positive correlation exists between workers' safe behavior and safety climate on mining sites in China. The workers' attitudes and behaviors are the most important antecedents to unsafe acts, accidents, and injuries, and the first line workers play the primary role in accidents. Unsafe behaviors are said to both directly and indirectly contribute to 90％ of all accidents and incidents. The proponent of safety behavior believes that at risk behaviors lead to more accidents/injuries. The fewer the at risk behaviors, the better is the safety standard in mines. Further accident research showed that emotionally unstable and job dissatisfied persons are associated with risk taking behaviors, which leads to accidents. The research indicates that the negatively affected and dissatisfied persons have less control to their task and as a result they are unable to cope up with proper safety practices and are more risk taking, so they are facing more injuries [10].

There are two main approaches to reducing accidents and improving safety in coal mines. The first is safety engineering, which is dominant in the safety field. Safety engineering concentrates on safe physical environments including mechanical features for accident prevention and other features such as non-slip surfaces, shoring for dangerous working faces, ventilation establishments and so on. The second approach is the behavioral approach, which aims to improve safety through tools such as safety training and organizational safety behavior interventions. In these approaches management tries to improve and change mine safety level by influencing worker behavior rather than by changing the physical setting. For example, management tries to modify behavior by providing motivations (rewards). These managerial strategies provide an important organizational control mechanism that improves safety performance. So, using motivation theory to improve workers' safe behavior levels and, ultimately reduced accidents and injuries is an effective method in coalmine safety. Based on the above analysis, practical safety countermeasures targeted at the coalmine accident are recommended in terms of coalmine zone accident control and prevention.

3. Relationship of motivation and work behavior

Motivation theory is a core theory of the behavioral science, which is used for dealing with relationship of need, motive, objective and behavior. The behavioral science thinks that the person's motive comes from need and need confirms people's behavioral objective. As a kind of inner activity, motivation plays the function of inspiring, driving and strengthening human behaviors. Therefore, motivation can be defined to a kind of process in which to influence person's innate need or motive for the sake of given purpose, thus strengthen, lead or change people's behavior to be advantageous to the organizational objective development [11]. Safety motivation indicates comprehensively using modern scientific principles and methods of management science, economics and so on, with purpose of preventing accidents and disasters and guaranteeing systems operation at the acceptable safety level, reasonably motivates the person in the system, thus leads and controls its behavior to match safety norms, not only promises an individual safety, but also promise the safety of organization (business enterprise) environment or even social safety [12-13].

Motivation has a supporting function in organization system. Whether the organization members express the behavior which organization hopes has to depend on the motivation to accomplish it [14]. In the organization system, the displacement of motivation's focus will influence the organization member's work cognition and the corresponding work behavior adopting from it, which is to say, the motivation is the medium which regulate organization member's work cognition and work behavior. The information of organization intention and arrangement act on the individual through the motivation carrier. Two key factors to realize the organizational objective are placed in the both ends of the lever balance, and the equilibrium of the lever intends that the work cognition, work behavior and the motivation match soundly. One end of the lever balance is work cognition, which reflects the cognition of organization members to organization intention and arrangement etc on the individual level, and the result will directly influence the method and effect of the work behavior. The other end of the lever balance is work behavior, namely the behavioral method in accomplishing work that the organization member expresses on the basis of work cognition. Another factor which has a key function to the equilibrium of the lever is its fulcrum, namely the motivation.

The relationship of motivation with work cognition and work behavior can be expressed as: the organization member forms decisions whether and how behaves on the basis of work cognition. After performing certain work behavior, the organization member will require motivation to the result of behavior, and then, the organization member will carry on new round work cognition to the effect information of motivation, and start a new round circulation. This process continuously repeats, the organization members accomplish their work tasks through the repeated circulation of cognition-behavior-reinforcement-recognition in this system.

4. Construction of the motivation system in coal mine

To enterprise, how to achieve safety output as much as possible through paying as small as safety guarantee costs is a problem which every enterprise management especially the coalmine management has to put a high value on and seriously study. Under the premise of fully adopting scientific safety techniques, it is very beneficial to the reduction of accident costs, advancement of economic benefit, setting of enterprise's prestige and long-term development of enterprise if can design a kind of reasonable motivation mechanism to employee in order to impel employee to support and guarantee safety with self-consciousness and of his own accord.

To coalmine enterprise, the safety motivation is the economical efficiency which mobilizes employees to value work safety and eradicates completely accidents. In practice, the coalmine enterprise needs to implement the safety motivation mechanism, raise employees' safety consciousness, and mobilize employees' positivity through the following methods:

4.1 Set up motivation mechanism of 'people foremost'

The person is the most important and the premier resource, and also most need to be respect, understand and stimulate. The safety must protect human's life and health in the first place and protect other resources such as property etc in the second place. Therefore, in the safety, the person is placed on the first all the time.

The motivation theory is a theory which researches the human need, motive, objective and behavior regulation to vitalize and control human good work behavior. The motivation takes human need as the jumping-off port and vitalizes person's work positivity, accordingly achieve the objective by satisfying his need. Once the objective is attained, the need is satisfied, thus the motivation process finishes. At the same time, another need will become strong, on this account, the behavior changes and point at the next objective. Not that all objective can be attained. When the behavior is frustrated, it is possible not to attain the objective, even has to give up the objective or transfer the objective's direction [15].

From the safety angle, person is not only the subject of management but also the object of management; not only the sufferer of accidents but also the trigger of accident under the most conditions. If there is no safety management, there is no system safety. Realizing the function and purpose of safety management is the necessary premises which actualizes any system safety. But to realize the function and purpose of safety management, obviously can not get away from the motivation and control of individual-each layer (decision, performance, operation layer).

Therefore, actualizing the motivation mechanism in coalmine enterprise, it firstly need analyze and understand what do employees need most, and then try to satisfy them with certain form. Aim at the inner need of employee of different type and different layer, it need adopt different and suitable motivation factors and measures and take the effective motivation forms, thus make employees of each layer can full play to their techniques and talents.

4.2 Establish a full range of motivation model

The basic need of people is the material need. Generally speaking, the higher the satisfaction degree of material need, the higher the work positivity of people and more obvious of motivation effect. The premier need of Chinese employee is still the economic need, therefore, the material motivation is still an important means, but, the person's value and dignity are the most important spirit support in life, so, the positivity which shines with respecting person's value and dignity is far great and persistent than the positivity which is mobilized by money and material. With employee's need entering into the layer of respect and self-fulfilment, the simple material award and economic means are hard to be effective. Therefore, it has to take the material and spirit to combine scientifically and organically in motivation, and must be abundant and multiform in forms, then can guarantee to realize the dynamic and maximization of motivation effect.

On the basis of the material motivation, persist positive motivation, adopt the principle of praise and commendation, respect the value orientation and independent personality of employee of each level, especially respect the rock-bottom employee and common employee, make the self-worth of employee get affirmed in work, in this way, people will be full of enthusiasm to work and can cooperate mutually.

4.3 Construct safety work environment, strengthen safety education and training

The management science thinks, under the circumstance of established exterior environment of organization, the work performance is mainly then dependent on the work environment (condition), work ability and positivity, and the safe production is dependent on the operation environment (condition), safe manipulative skill and positivity. Supporting the safe production is a systems engineering. Mobilizing people's positivity of accident prevention with safety motivation awards just realized a controllable factor of safe production performance, but two other factors, namely the guarantee of safe operation environment and the training and evaluation of safe operation technique, are then directly related with the organization itself.

Once the operators find that the equipment and device that they are using are unsafe, even if they obey the operational procedures and face the favourable motivation system of company, still will feel nervous and unsafe. Therefore, the safety motivation must be carried on synchronously with improving work environment, strengthening safety construction and inspection, and the organization must provide safe working environment and protect operators' life safety and property safety.

Along with modern technique gradually complicated and the demand of operation management level high, the enterprise leaders must be aware that only continuously enhance the officers and workers' techno-culture qualities, safety technical ability and safety consciousness, develop officers and workers' potential, then can strengthen the accident prevention ability and work safety level of coalmine enterprise radically. So it needs to unremittingly insist on carrying on safety training and education to officers and workers, especially advocate the prize winners sharing their experience, lessons and skills with the

organization members, encouraging them to study to the safety models, in order to spirit up employees' safety responsibility and ambition, bring a good motivation to the safety production, thereby improve the whole safety consciousness and accident prevention level of organization.

4.4 Strengthen person's positive behavior and rectify negative behavior

The human behavior can be divided into the positive behavior (namely, the behaviors which are accord with each rule and system and can bring good result which is conformable with "need") and the negative behavior (namely, the behaviors which are against the rule and system and cause kickback which is unable to satisfy "need") because of the influence of many unascertainable factors [16] .

In the coal mine safety, the positive behavior refers to person's safe behavior, and the negative behavior refers to unsafe behavior. The human unsafe behavior, namely the negative behavior not only can't satisfy need, but also result in the wicked aftermath. The empirical study indicates that the usage of behavior modification methods in human motivation brought the impressive performance development [17]. Therefore, the safety management of coal mine enterprise can figure behavior through the way of strengthen or restrain the behavior result by positive and negative event, namely influence the character and direction of behavior by using positive reinforcement, punishment, abolition and negative reinforcement and so on. Using the positive reinforcement and negative reinforcement of the positive and negative event to increase the frequency of ideal behavior, and decrease the frequency of un-ideal behavior, strengthen employees' safe behaviors, restrain and decrease the unsafe behaviors.

4.5 Strengthen motivation of high-middle-level safety governors

In former motivation jobs, the motivation was always with an eye to the rewards and punishment and the spiritual motivation to rank and file employee and operation layer, but lacked the theoretical discuss and practice to the high or middle-level managers and the enterprise operators.

As a matter of fact, the motivation to the common employees is relatively easy and secondary. Relatively to say, the job of the high or middle-level managers is a complex and dynamic system and the perceptible factors are usually the non-linear results of the multidimensional factors. Therefore, the motivation and inducement to high or middle-level safety managers are relatively complex but important.

The whole diathesis of the front-line workers in Chinese coalmine enterprises is low, the high or middle-level safety management professionals are lack, the foundation of safety management is weak and the management level is not high. The duration of schooling that a safety manager received correlates significantly with his performance in routine safety management and that a safety manager with more schooling tended to perform better on safety management. Hence enhancing safety quality of manager's is considered to be the key to improve the safety management performance on coalmine safety in China. So, it should set up the training system of institutionalization, and put the training of administrator and executive and middle-level managers at first, train a group of safety managers, technologist and operation experts with high diathesis.

5. Conclusions

1) The developed countries' experience has already proved, in safety production, it is no doubt important that improving the operators' working conditions and safety apparatus actively, but, the objective which is threatened by accidents is the person, it depends on the person in the final analysis to carry out safety institutions, prevent and stop accidents. The causation analysis of accidents has already proved that the personal factor is the main reason that the coal mine accidents occur frequently. Therefore, it is important way of thinking that improves the coal mine safety in China effectively that how to strengthen safety management to person, fully mobilizing people to cherish and protect their own pressure and responsibility by motivation means, enhancing the positivity and initiative of safety production.

2) On the basis of the related motivation theories, the situation and cause of coal mine accidents were deeply analyzed in this paper and a safety motivation mechanism system of coal mine was put forward. Hope that it is can offer certain reference to safety management of coal mine and certain theory value and practice meaning to the construction and improvement of coal mine safety.

3) It is a long-term and sustaining work that theory comes into being system. Because the financial resources and manpower are limited, many works are hard to be appropriately resolved in this paper. The other problems of safety motivation mechanism construction, such as the motivation to the knowledge-type employee, improvement of the

expectancy theory and establishment of motivation safety culture and so forth await the farther study, discussion and improvement.

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